

# Land Surface Process and Air Quality Research and Applications at MSFC

Dale Quattrochi and Maudood Khan

National Space Science and Technology Center,  
George C. Marshall Space Flight Center  
Huntsville, AL 35805

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*Land Processes Group, NASA Marshall Space Flight Center, Huntsville, AL*



# Outline

- Previous work:
  - Effect of accurate land surface characterization on atmospheric modeling results
- On-going work:
  - Creation of a modeling test bed:
    - Incorporate 2001 NLCD LULC data within ARW
    - Atmospheric modeling simulations for the 2006 calendar year using MM5 and ARW/CMAQ and SMOKE modeling system
  - Applications:
    - Public health
    - Urban Heat Island (UHI) and aerosols
    - Energy management
    - Use of satellite derived meteorological products for model validation



# Land surface characterization in atmospheric models



# USGS LULC aggregated to 4 km



- Urban
- Crops/Pasture Mosaic
- Grass/Crops Mosaic
- Woodland/Crops Mosaic
- Shrubs
- Deciduous Forest
- Evergreen Forest
- Mixed Forest
- Water

# Combined NLCD and LandPro99 LULC aggregated to 4 km



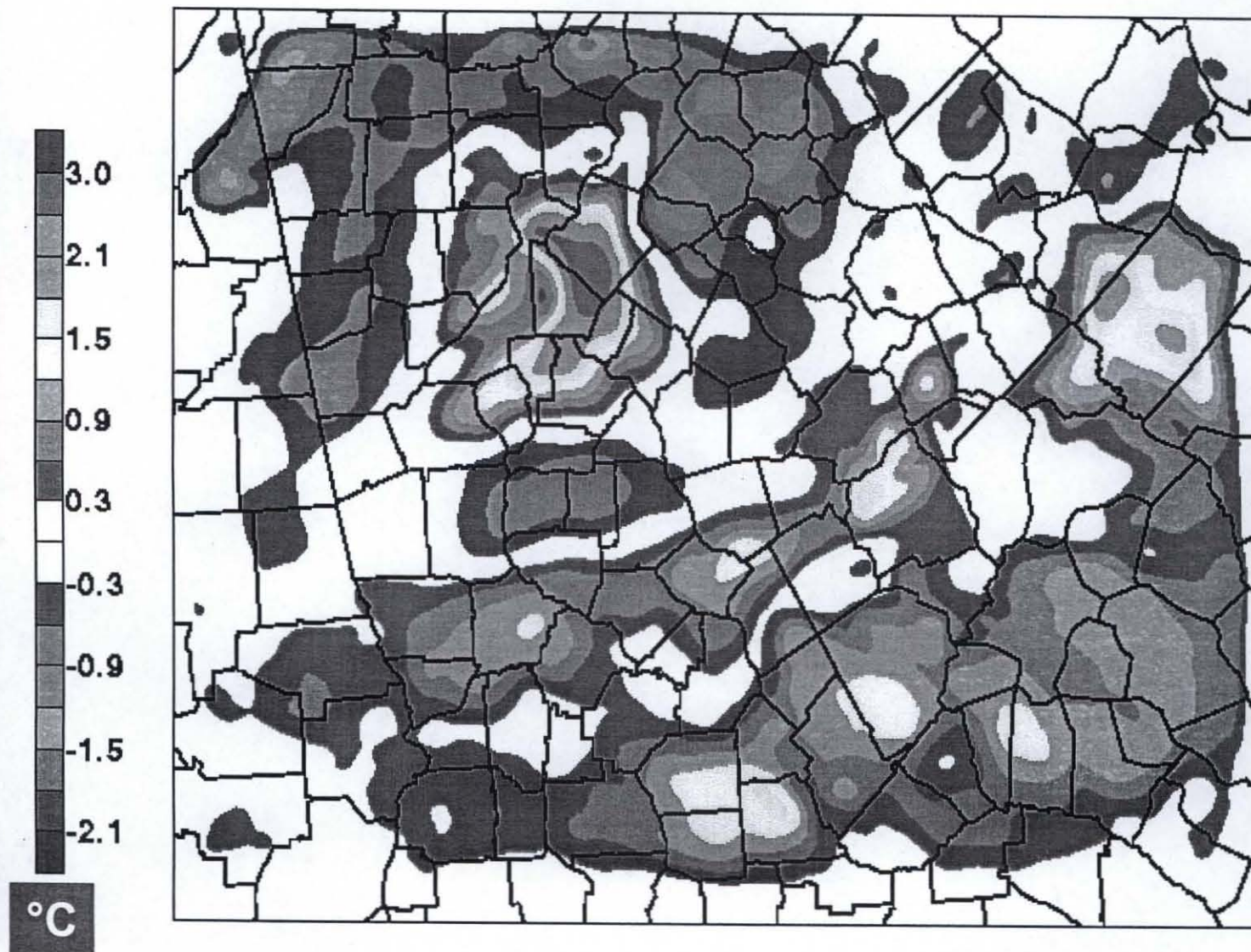
- Low Density Residential
- Med. Density Residential
- High Density Residential
- Commercial/Services
- Institutional
- TCU
- Industrial/Commercial
- Water
- Crops/Pasture
- Row Crops
- Deciduous Forest
- Evergreen Forest
- Mixed Forest
- Woody Wetlands
- Quarries/Mines/Gravel Pits
- Transitional

'Crops/Pasture Mosaic'

'Medium Density  
Residential'



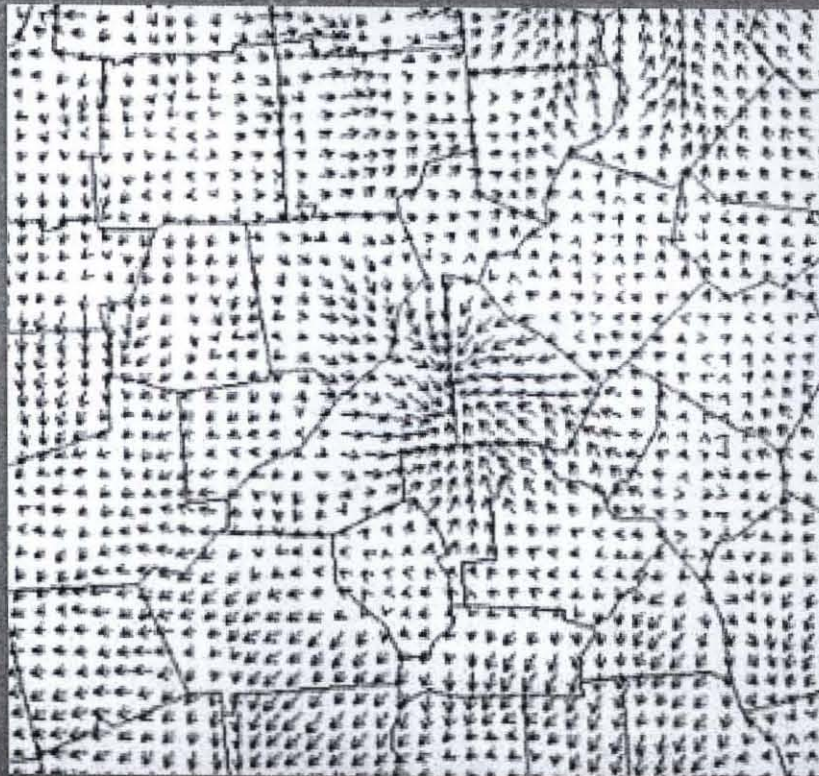
# 10m air temperature 17 August, 2000 @ 21 UTC



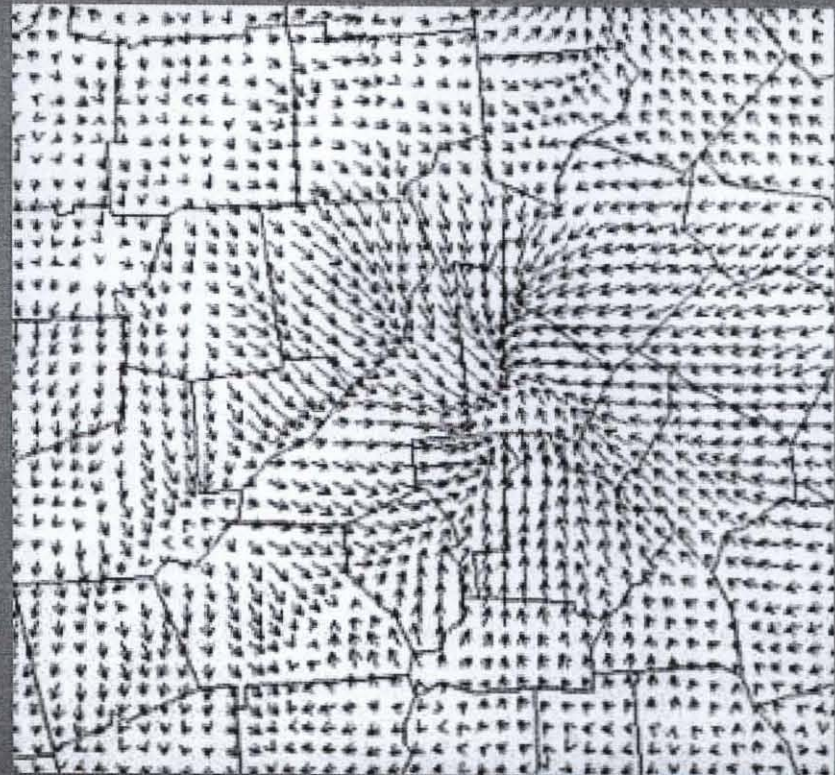


# 9-day mean surface winds

USGS



NLCD/LandPro99



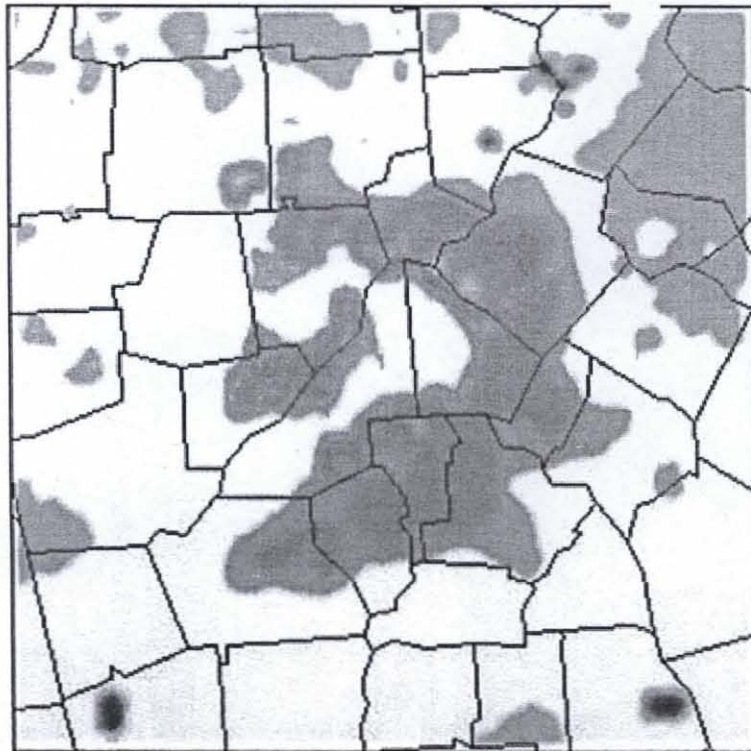


# 9 day mean difference in PBL heights (NLCD/LandPro99 – USGS)

2:00 PM

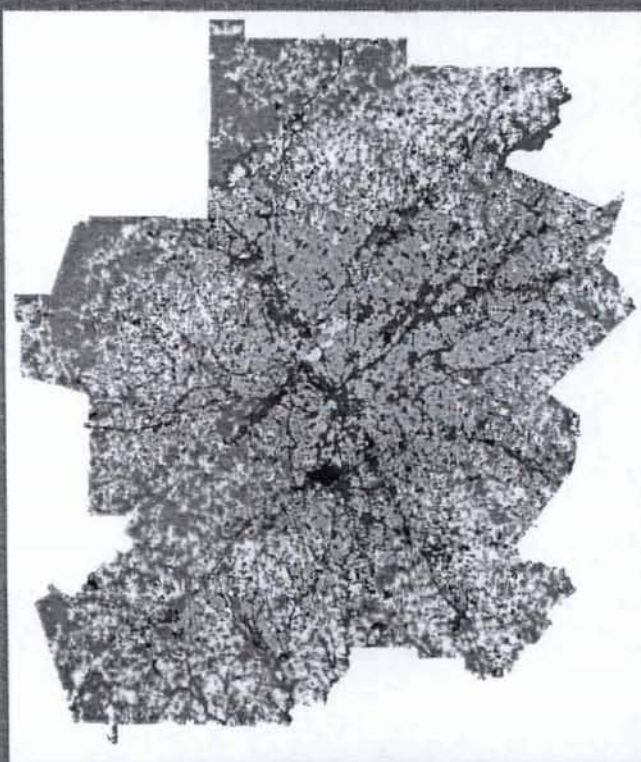
7:00 PM

2000  
1600  
1200  
800  
400  
0  
-400  
-800  
-1200  
meters

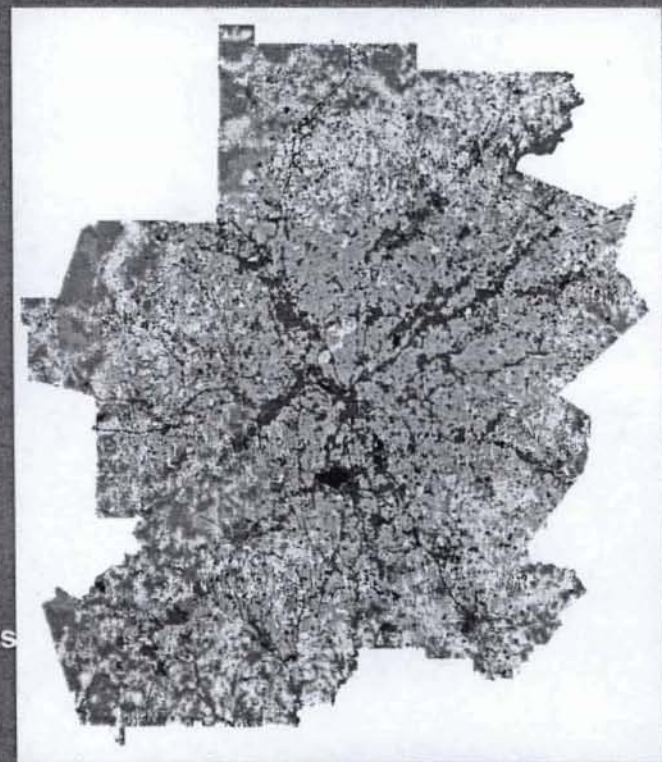




## Current (1999)



## Projected (2030)



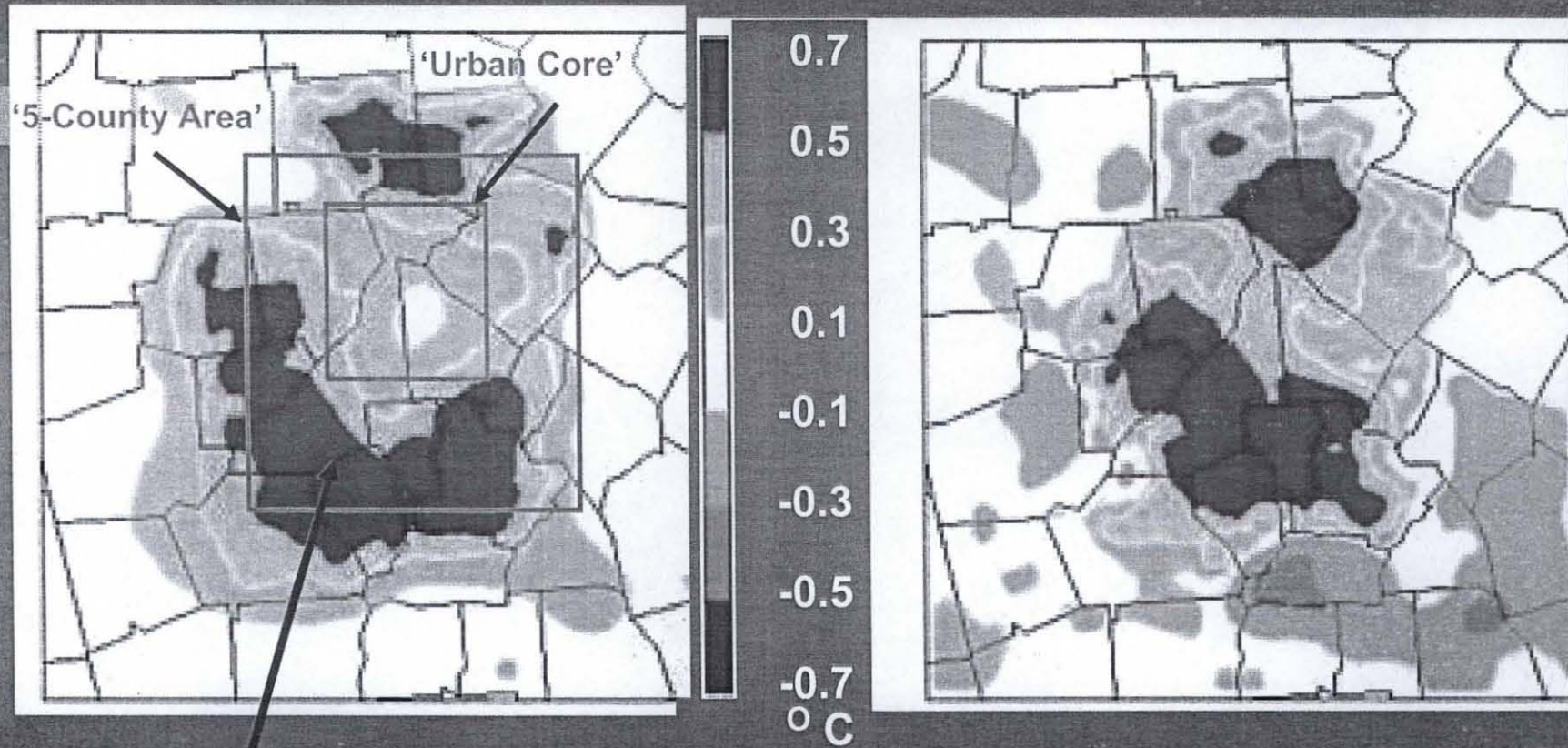
The Spatial Growth Model (SGM) was used to project land use/land cover for the area to 2030.  
SGM inputs: current and projected population, employment, and road networks.



# 9 day mean difference in 10m air temperature (2030 Business as Usual – 2000 Baseline)

2:00 PM

7:00 PM

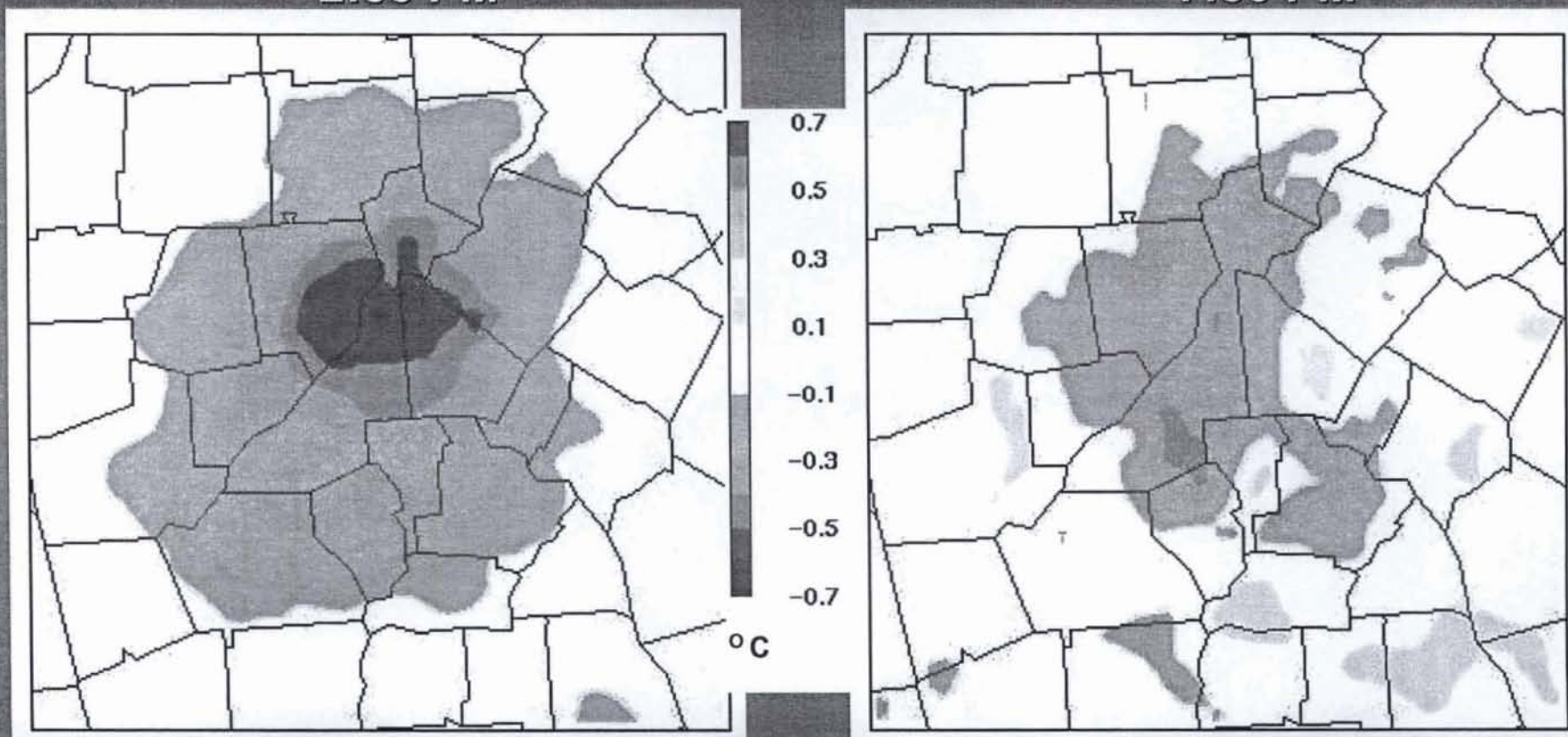




# 9 day mean difference in 10m air temperature (2030 Mitigation – 2030 Business as usual)

2:00 PM

7:00 PM

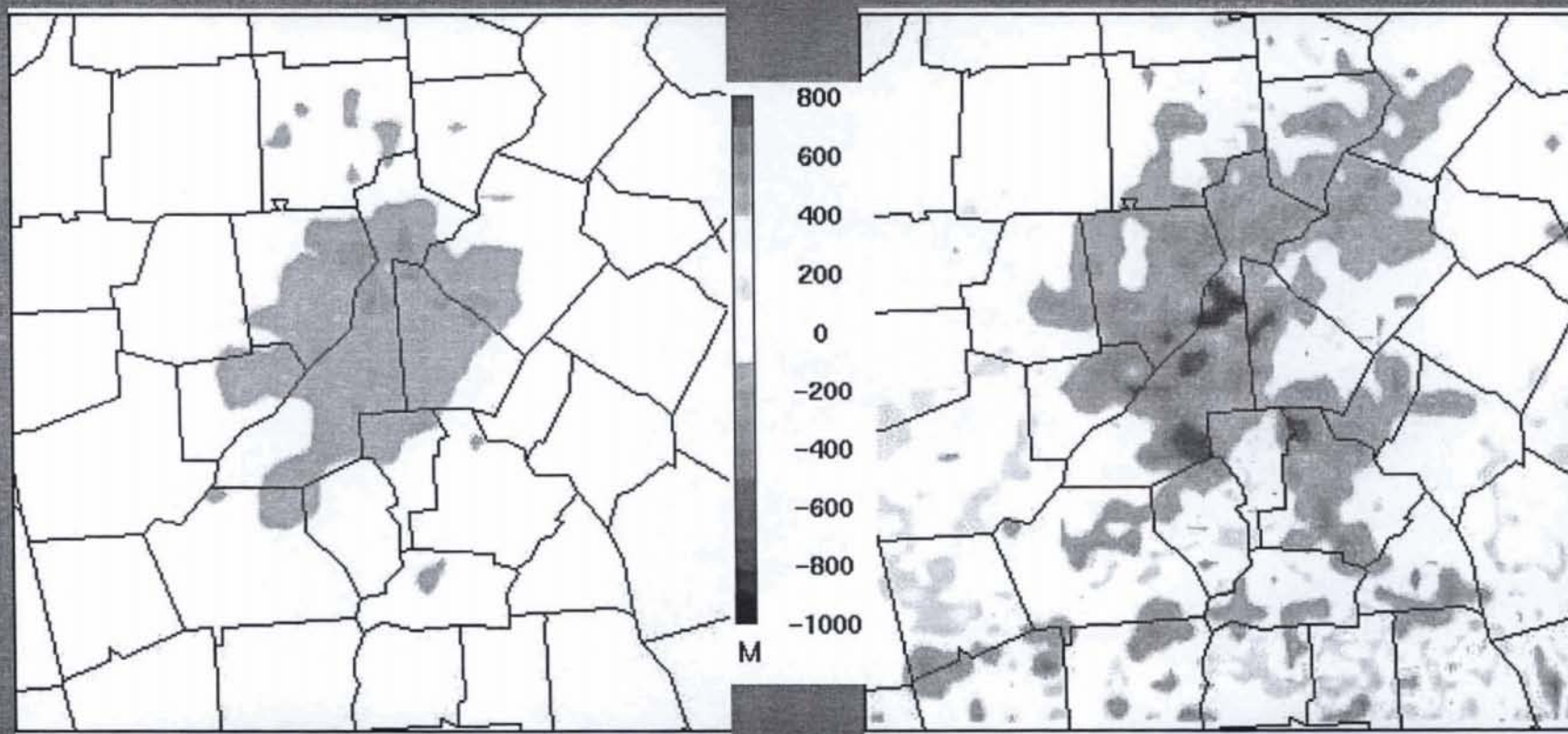




# 9 day mean difference in PBL height (2030 Mitigation – 2030 Business as usual)

2:00 PM

7:00 PM

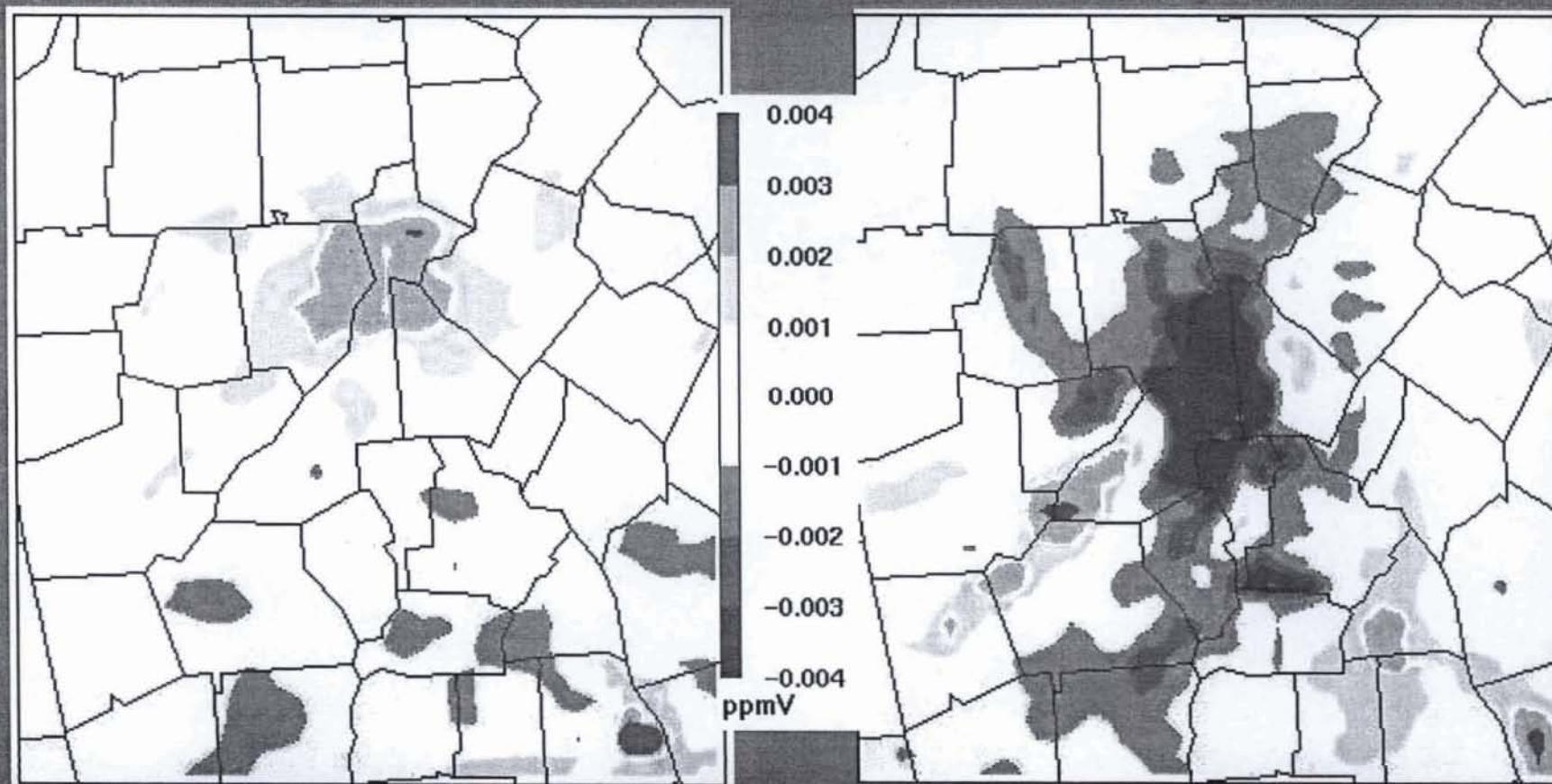




# 9 day mean difference in Ozone concentrations (2030 Mitigation – 2030 Business as usual)

2:00 PM

7:00 PM

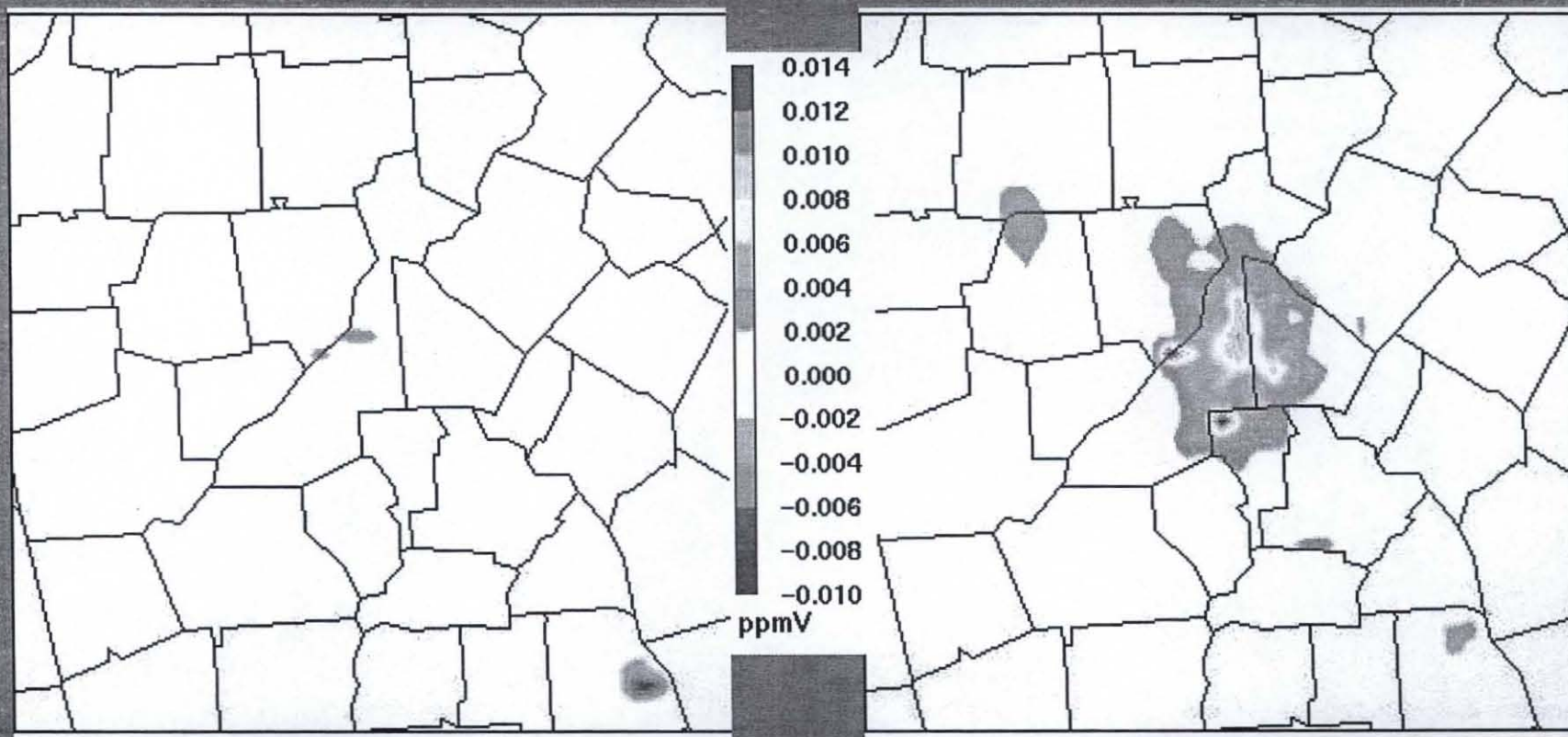




# 9 day mean difference in NO<sub>x</sub> (2030 Mitigation – 2030 Business as usual)

2:00 PM

7:00 PM



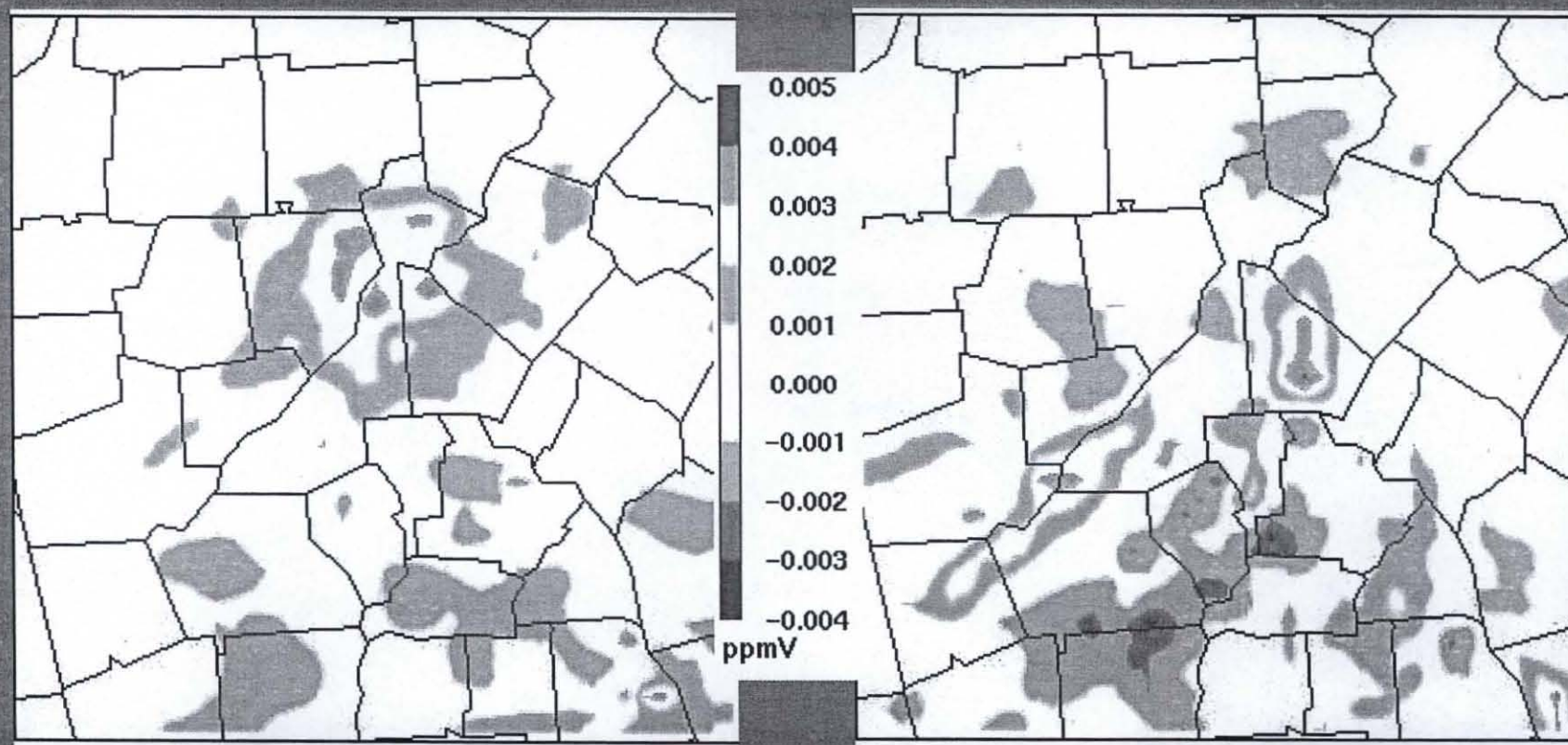


# 9 day mean difference in O<sub>3</sub>+NO<sub>2</sub>

(2030 Mitigation – 2030 Business as usual)

2:00 PM

7:00 PM





# On-going work

- Objective is to undertake a comprehensive spatiotemporal analysis of the effects of accurate land surface characterization on atmospheric modeling results
- Approach: Create a modeling test bed
  - Atmospheric modeling of the 2006 calendar year using MM5 and ARM/CMAQ/SMOKE modeling system
- Possible air Quality and public health applications
  - Improve air pollution exposure assessment through better characterization of the land surface and boundary layer processes, together with a more accurate assessment of the spatiotemporal distribution of population
  - Quantify the effect of Urban Heat Island (UHI) mitigation strategies on aerosols through use of dynamically coupled atmospheric models
  - Use of satellite derived meteorological products for model validation: An investigation to support development of guidelines for regulatory applications

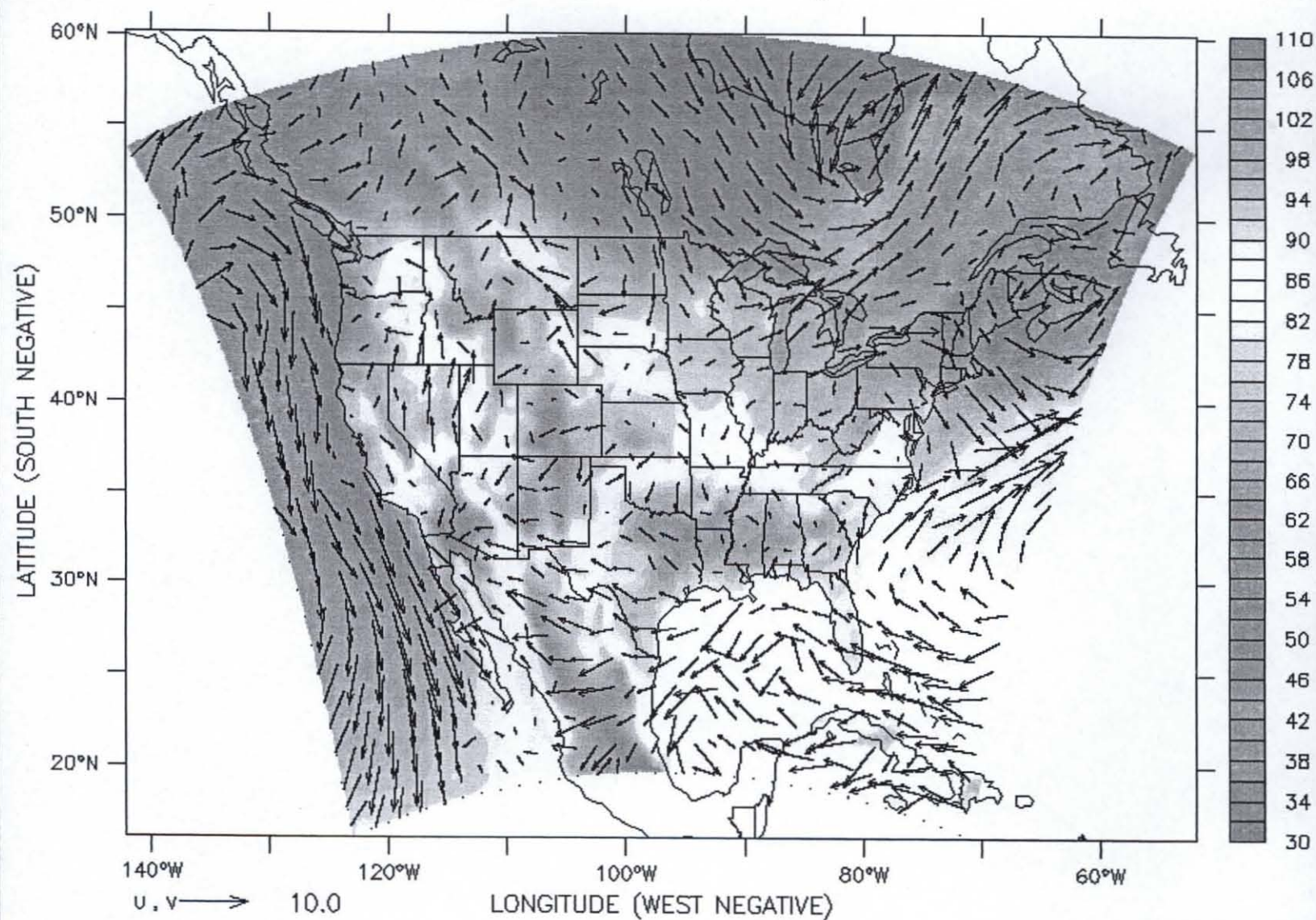


Z : 39

TIME : 21-AUG-2006 18:00

DATA SET: mmout.d1.20070603\_03

MM5 version 3 format output on sigma levels



Temperature (F)

Courtesy: Arastoo Biazar

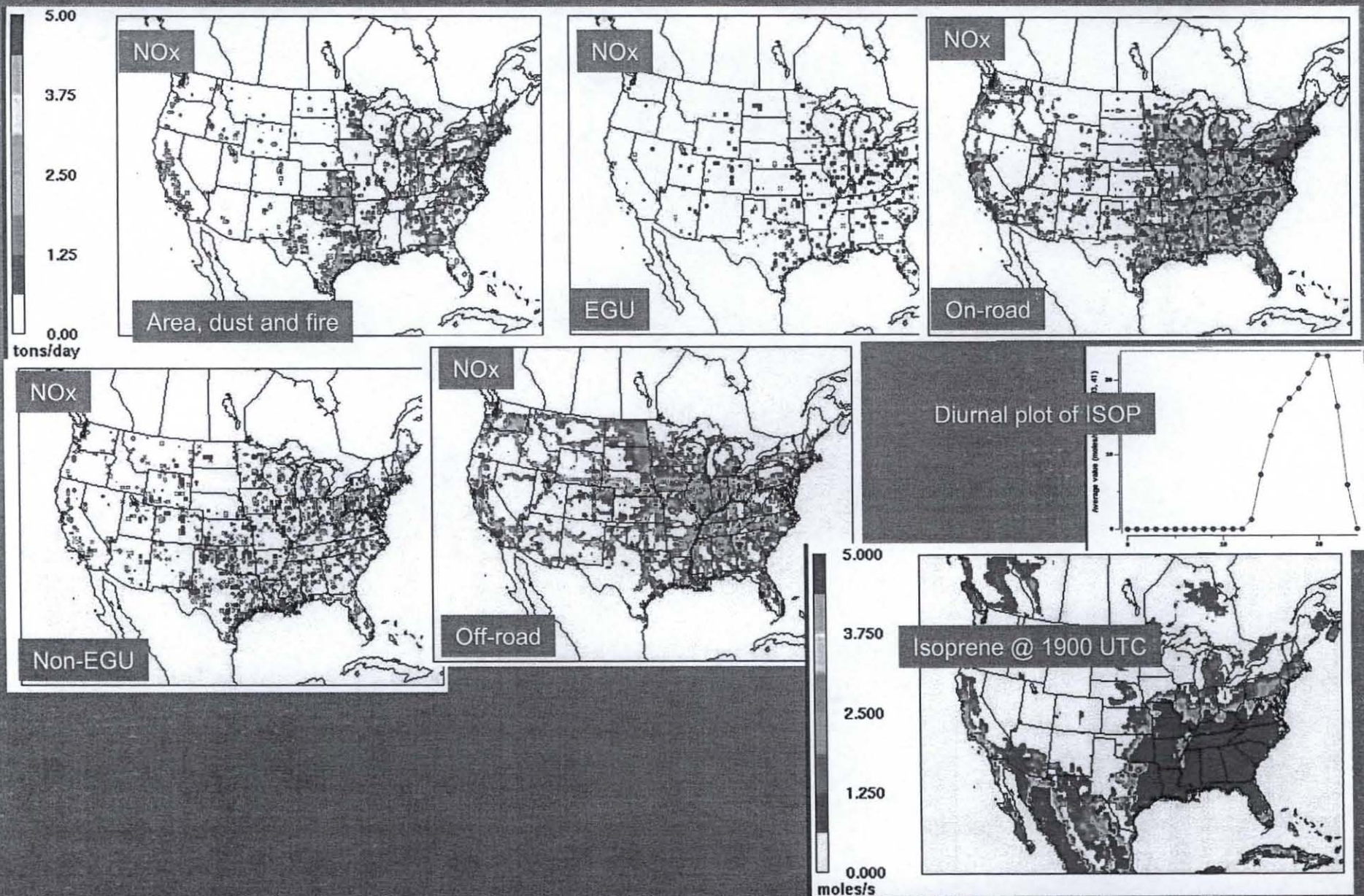


# Emissions Modeling

- Model: Sparse Matrix Operator Kernel Emissions (SMOKE) modeling system
- Purpose: Generate spatially, temporally and chemically resolved emission fields for air quality models
- Inputs: Source specific emission inventories, speciation profiles, temporal profiles, spatial surrogates, etc
- Source categories
  - Area (e.g., gas stations, dry cleaners)
  - Non-Electricity Generating Units (NEGU)
  - Electricity Generating Units (EGU)
    - Continuous Emission Monitoring (CEM) Data
  - Dust (e.g., wind blown, road)
  - Fire (e.g., prescribed, wild)
  - On-road mobile
    - Activity: Highway Performance Management System (HPMS) and Travel Demand Models (TP+, TRANSIMS)
    - Emission factors: MOBILE6 and MOVES
  - Off-road mobile (construction equipment, commercial shipping, aircraft and airport, etc)
  - Biogenics (BEIS, Biogenic Emissions Inventory System)



# Gridded Emissions





## Criteria Air Pollutant (CAP) emission updates

- Texas2006 Emissions inventory
- 2006 CEM data for EGUs
- Dust emissions inventory
- Fire emissions inventory
- Lightning NOx
- MOVES
- TRANSIMS

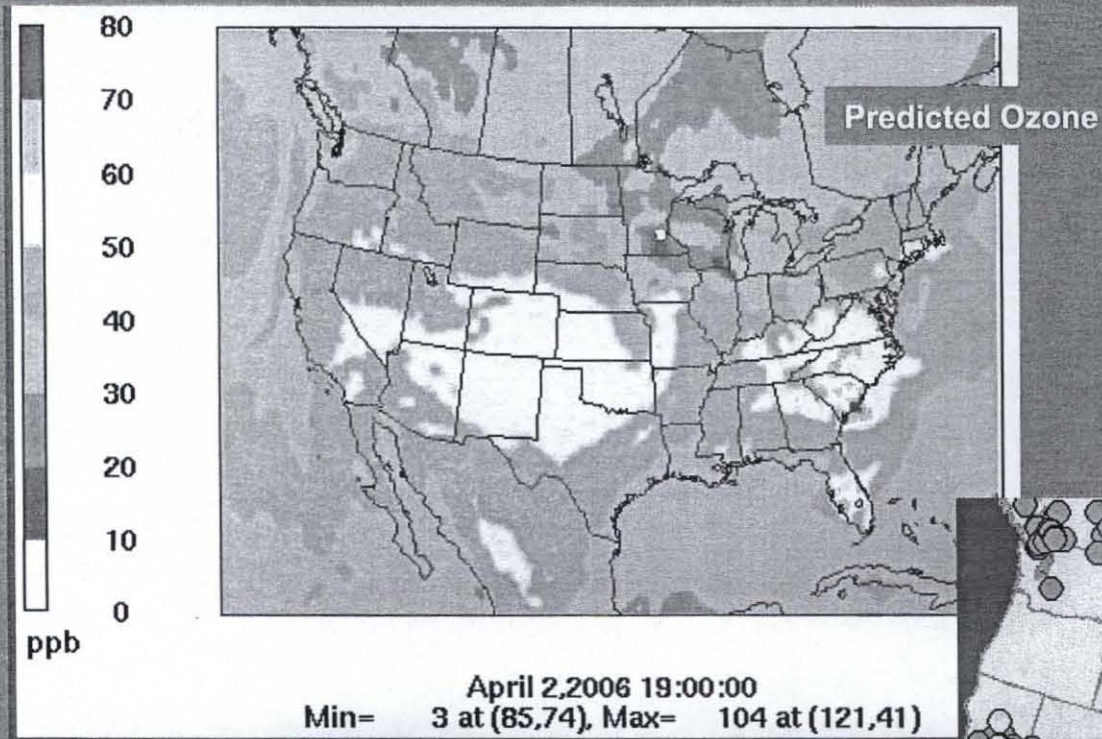


# Air Quality Modeling using CMAQ

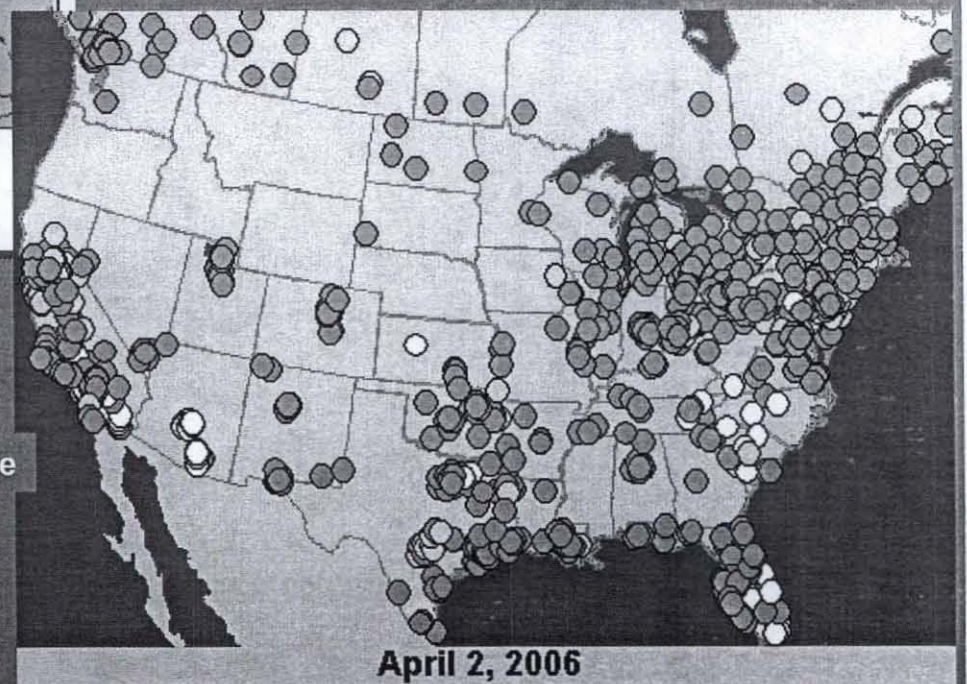
- CMAQ version 4.6
- Model configurations
- Input data:
  - BC/IC
  - Photolysis rates
- Standardized performance evaluation using EPA's Atmospheric Model Evaluation Tool (AMET)



# Daily Maximum hourly averaged $O_3$



Observed Ozone





# Health Effects of Air Pollution

- Model: Benefits Mapping and Analysis Program (BenMap)
- Purpose: Used to calculate health costs associated with air pollution
- Input:
  - Population distribution
  - C-R functions
  - Incidence rates
  - Valuation functions
  - Air quality data
  - Meteorological data

